

# Proposal to DST/DAE to support Indo-US Collaboration on Accelerator and Detector R&D

International Linear Collider: Accelerator

International Linear Collider: Detector R&D

High Intensity Proton Linac for Neutrino Physics

4<sup>th</sup> Generation Light Sources

Shekhar Mishra for  
Indo-US Collaboration

# Indo-US Collaboration History

- Since the start of the discussion in Dec. 02 with Prof. Ramamurthy we have been making progress.
- Interaction Meeting on Linear Collider and Neutrino Physics was held in New Delhi, Nov. 03. (Attended by 19 US and 70 Indian scientists) Followed by visits to CAT & TIFR.
- Indo-US working group was established by Prof. Ramamurthy and Prof. Witherell, Director of Fermilab.
- Working group met at Fermilab in Aug. 04 and a program of collaboration was discussed. All US and 2 Indian members participated.

# Indo-US Collaboration History (cont)

The following model was considered optimal to initiate such exchanges:

- US laboratories initially would accept say up to two Indian scientists at each of the collaborating US laboratories.
  - The project and details of each visiting persons would be decided by mutual interest. It is hoped that this will be an avenue to involve working level persons and hence most of these visitors are expected to be junior scientists and engineers.
  - The exchange visit period would be of say for minimum of 6 months each (although shorter length visit could still consider if need be) and there should be some overlap between the incoming and outgoing scientists at the various labs.
- US scientists will visit Indian laboratories for specific topics of interest to develop collaboration and building contacts, for example
  - Commissioning of Indus-II
  - Review of Indian accelerator projects
  - Holding Indo-US Accelerator Schools
  - Participation of US scientists in Indian conferences

# Indo-US Collaboration History cont.

- Funding for the travel and stay of these scientists in the two countries was discussed.
  - At present the US and Indian laboratories do not have funds earmarked to support scientific exchange between the two countries.
  - Host laboratories can provide office space, administrative and computing support.
  - Sources for living and travel expenses have to be found. It was decided that the Indo-US Accelerator R&D Working Group look into several sources of funding to support these visits.
- There are two existing Indo-US agreements for scientific exchanges that can be used to fund this collaborative research. It is also possible that India may have other funding mechanism to support these activities.
  - The Indo-US Science Forum: for short visits, attending workshops etc
  - India DAE and India DST funds long visits by Indian scientists
  - US DOE funds long term visits by US scientists

# Action Item: Four proposals will be submitted to funding agencies (Oct. 04)

- **International Linear Collider (ILC):** The ILC is the primary goal of the accelerator R&D collaboration. It is realized that to achieving this goal we must collaborate on other accelerator projects. We will submit a proposal to Indo-US Science Forum to support travel related to the Accelerator R&D. PI: Shekhar Mishra, USA and Vinod Sahni, India
- **High Energy Physics Detector R&D:** India has already made significant contributions to High Energy Physics Detector R&D and construction as well as their installations in some labs in USA. India could therefore naturally participate in a International Linear Collider Detector collaboration and related R&D. We will submit a proposal to DST-NSF to support this activity. PI: Harry Weerts, USA and, (nominee to be decided by) India.
- **Neutrino Physics:** Fermilab, BNL and many institutions India have considerable interest in Neutrino physics. We will submit a proposal to DST-NSF to support this activity. PI: Doug Michael, USA and (nominee to be decided by) India.
- Fermilab and BARC/TIFR teams in India have considerable interest in astroparticle physics of which gamma ray astronomy is an important part. There is an opportunity to forge new partnership especially in the context of planned Indian Gamma Ray Telescope at Hanle, Ladhakh. PI: and (nominee to be decided by) USA and R Koul, India.

# Progress Since Nov. 03

- Administrative:

- Dr. Vinod Sahni has been appointed to be the new member of ICFA. After 15 years of no representation and reorganization India is a member of ICFA.
- Dr. Sahni has also become a member of ILCSC.
- India has been invited to participate in the Finance/Funding Agencies discussion for the Linear Collider Funding held at London.
- Dr. Atul Gurtu from TIFR represented India at a meeting end of last year.
- Indian scientists have been named to International Committee for ILC.

- Scientific:

- Indian scientists have received invitation to give invited accelerator talks at International conference in consultancy with the Indo-US working group. (Germany, PAC05, LCWS05, Snowmass...)
- US Scientists have received invitations to participate in Indian conferences
- Importance of Indian collaboration is being discussed at every meeting of ILC
- Indian scientists have started participating in ILC work at Fermilab.
- ILC technology selection was made on Aug. 20<sup>th</sup> 2004. This made the Indo-US common interests closer.

# **EMITTANCE DILUTION IN NLC MAIN LINAC (1 TeV CM): DISPERSION FREE STEERING**

**Kirti Ranjan and Ashutosh Bhardwaj  
University of Delhi, India**

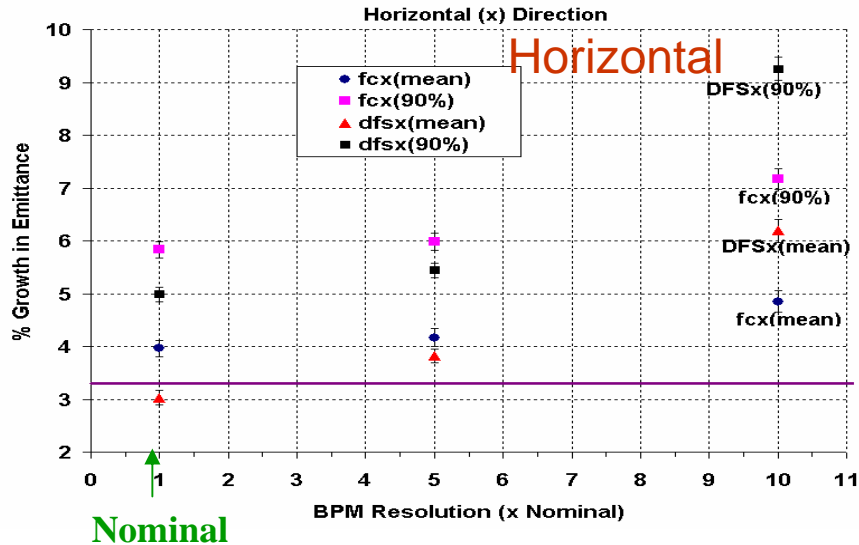
**&**

**Peter Tenenbaum  
Stanford Linear Accelerator Center**

**&**

**Shekhar Mishra  
Fermi National Accelerator Laboratory**

# BPM RESOLUTION

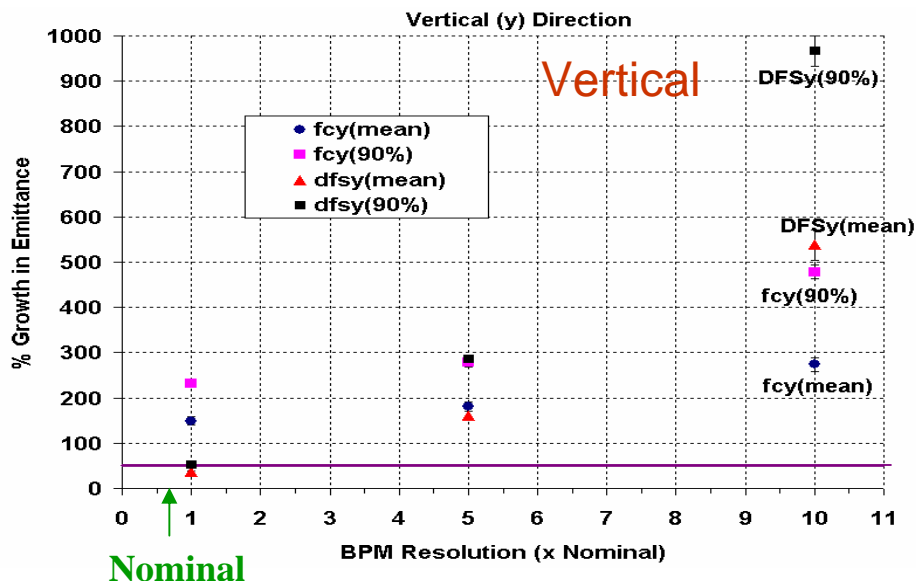


➤  $\gamma\epsilon_y$  &  $\gamma\epsilon_x$  growth in FC:

- ➡ Lesser dependence, but,
- ➡ much above tolerance.

Nominal Values

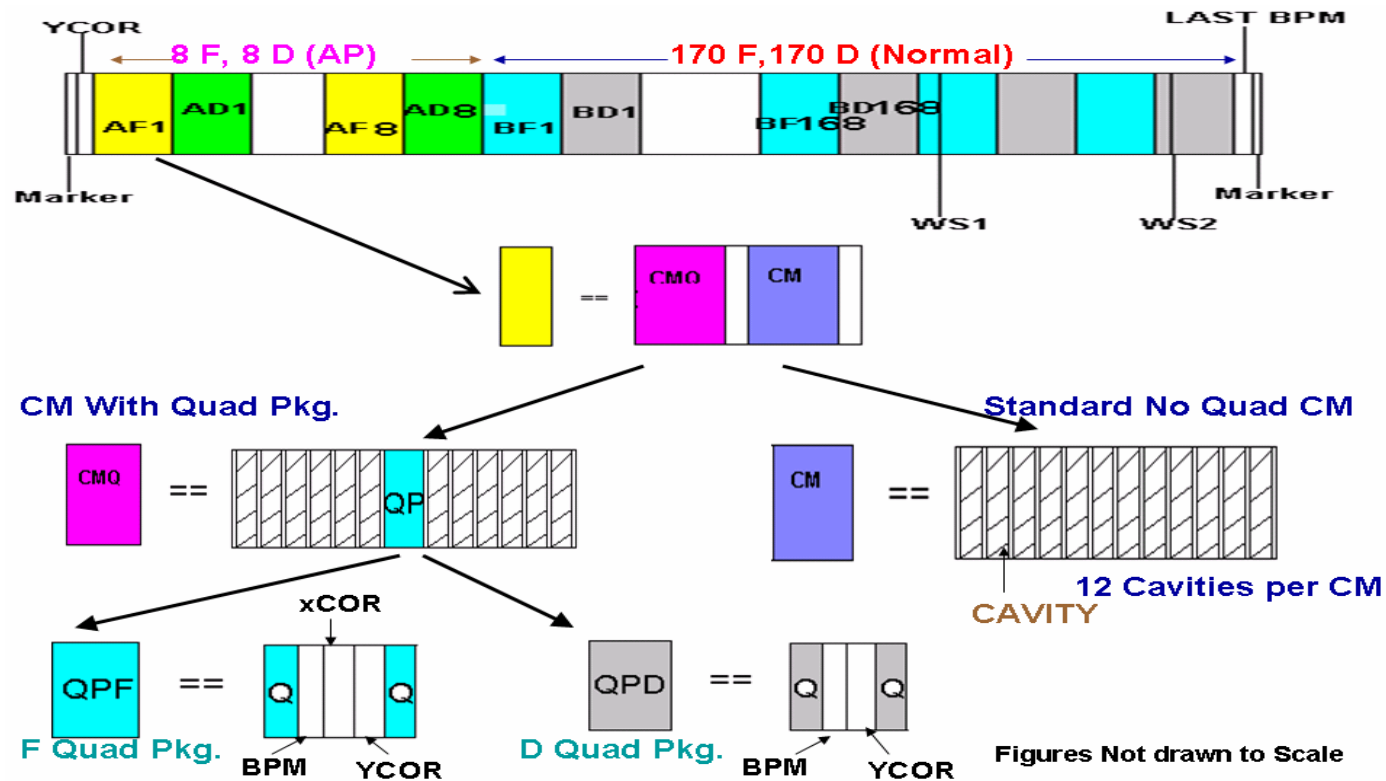
RMS offset in x / y plane : 0.4  $\mu\text{m}$  / 0.4  $\mu\text{m}$



➤  $\gamma\epsilon_y$  &  $\gamma\epsilon_x$  growth in DFS:

- ➡ Depends heavily on BPM resolution.
- ➡ Should remain within nominal values.

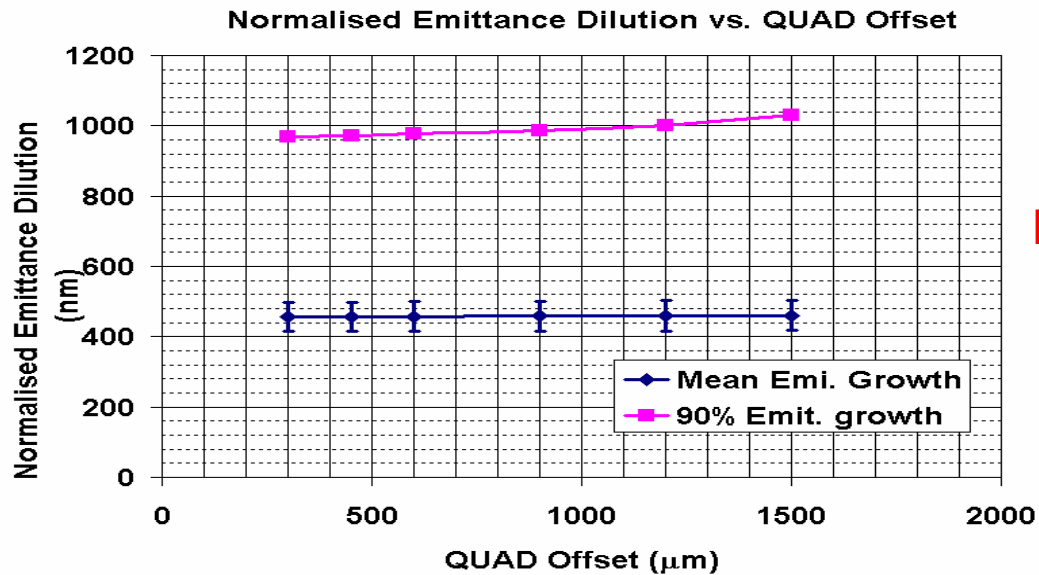
# MATLIAR SIMULATION: USCOLDLC MAIN LINAC (500 GeV CM)



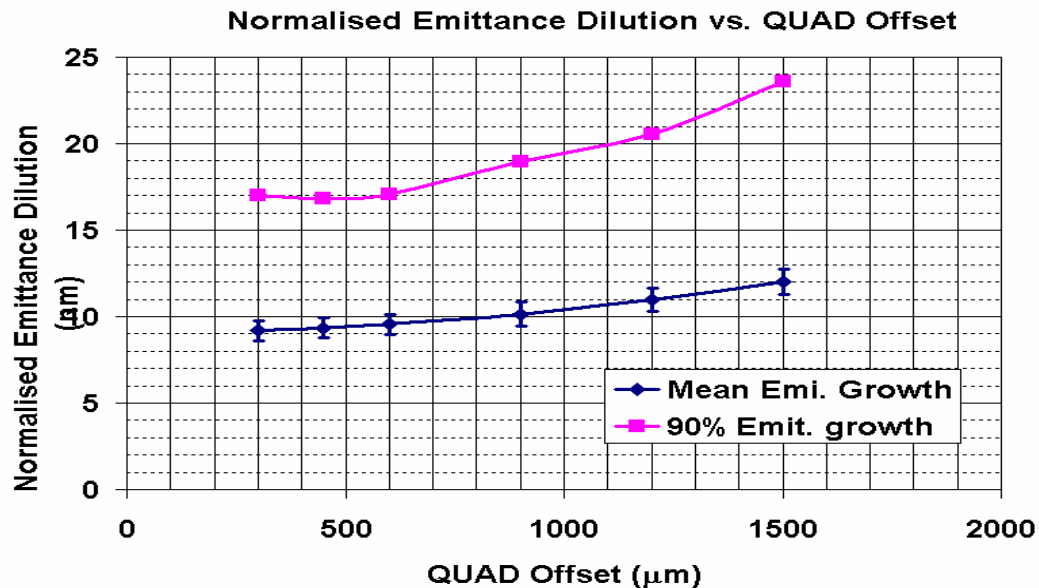
## ➤ US Cold LC Main Linac Design

- ⇒ Adapted from the TESLA TDR
- ⇒ Linac Cryogenic system is divided into Cryomodules(CM), with 12 structures / CM
- ⇒ Superconducting Quads in alternate cryostats, 356 Quads (178 F, 178 D)
- ⇒ Magnet Optics is a FODO lattice, with  $\beta$  phase advance of  $60^\circ$  in each plane
- ⇒ Initial 32 CM are provided with Autophased cavities for BNS damping
- ⇒ Each quad has a Cavity style BPM and a vertical corrector magnet; horizontally focusing quads also have a nearby horizontal corrector magnet.

# EFFECT OF QUAD OFFSETS VARIATION



FLAT



DFS

# Proposal: ILC Accelerator Physics

- Base design of ILC linac
  - Emittance control
  - Vibration simulation
  - Feedback simulation
- Electron, positron source simulation
  - Space charge
  - Activation of positron source target vault
  - Conventional positron source drive beam energy
- Damping ring design (accelerators very similar to light sources)
- IR simulations (beam-beam)
- Analysis of innovative ideas

# Proposal: Possible Indian Contributions to Superconducting RF R&D

- R&D to emphasize complete design, construction, testing and industrialization concepts
- Possible contributions
  - Beam diagnostics and controls
  - Main Linac RF Power
    - Produce full-scale marx-type induction modulator based on SLAC prototype
    - Build waveguide components such as hybrids, directional couplers (for power distribution or monitoring of power), phase shifters (3-stub tuners), etc.
    - Develop controls for the L-band test stand
    - Industrial production of modulators
  - Main Linac SCRF Structures
    - High gradient RF cavity development
    - SC cryomodule fabrication and industrialization

# Proposal: Possible Indian Contributions to ILC Accelerator R&D

## ATF2 – Advanced Test Facility at KEK

- Build components – magnets, instrumentation, vacuum etc.

- Participate in design, simulation & experiments

## Positron Source

- Develop a superconducting flux concentrator

- Develop a uniform field solenoid for  $e^+$  capture

## Electron Source

- Develop source laser

- Prototype bunching

## Beam Delivery

- Refine background simulation, study collimation efficiency

- Develop beam instrumentation – laser wires, kickers

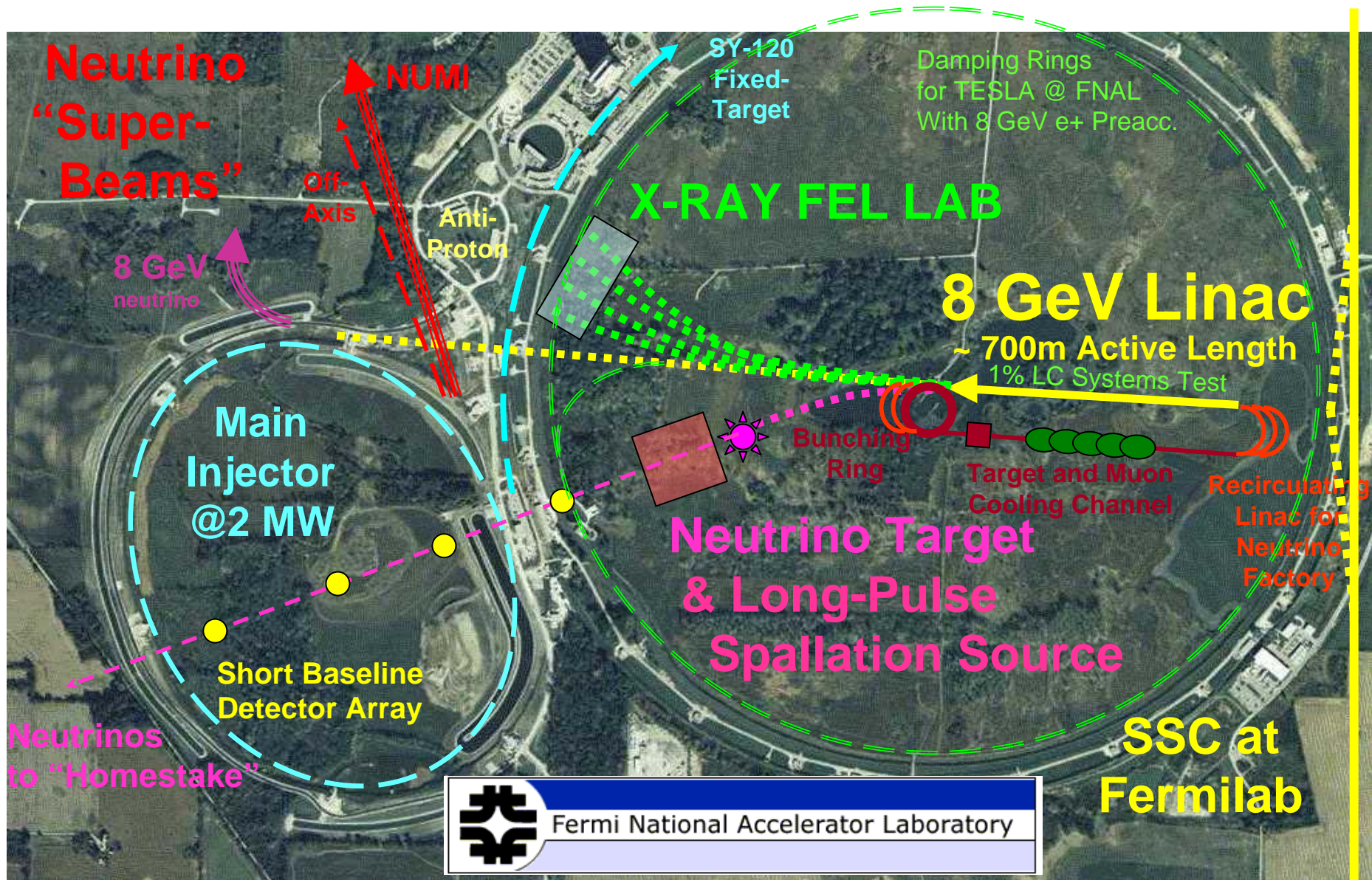
- Refine optics and tuning simulations

# Proposal: Collaboration on High Intensity Proton Beam

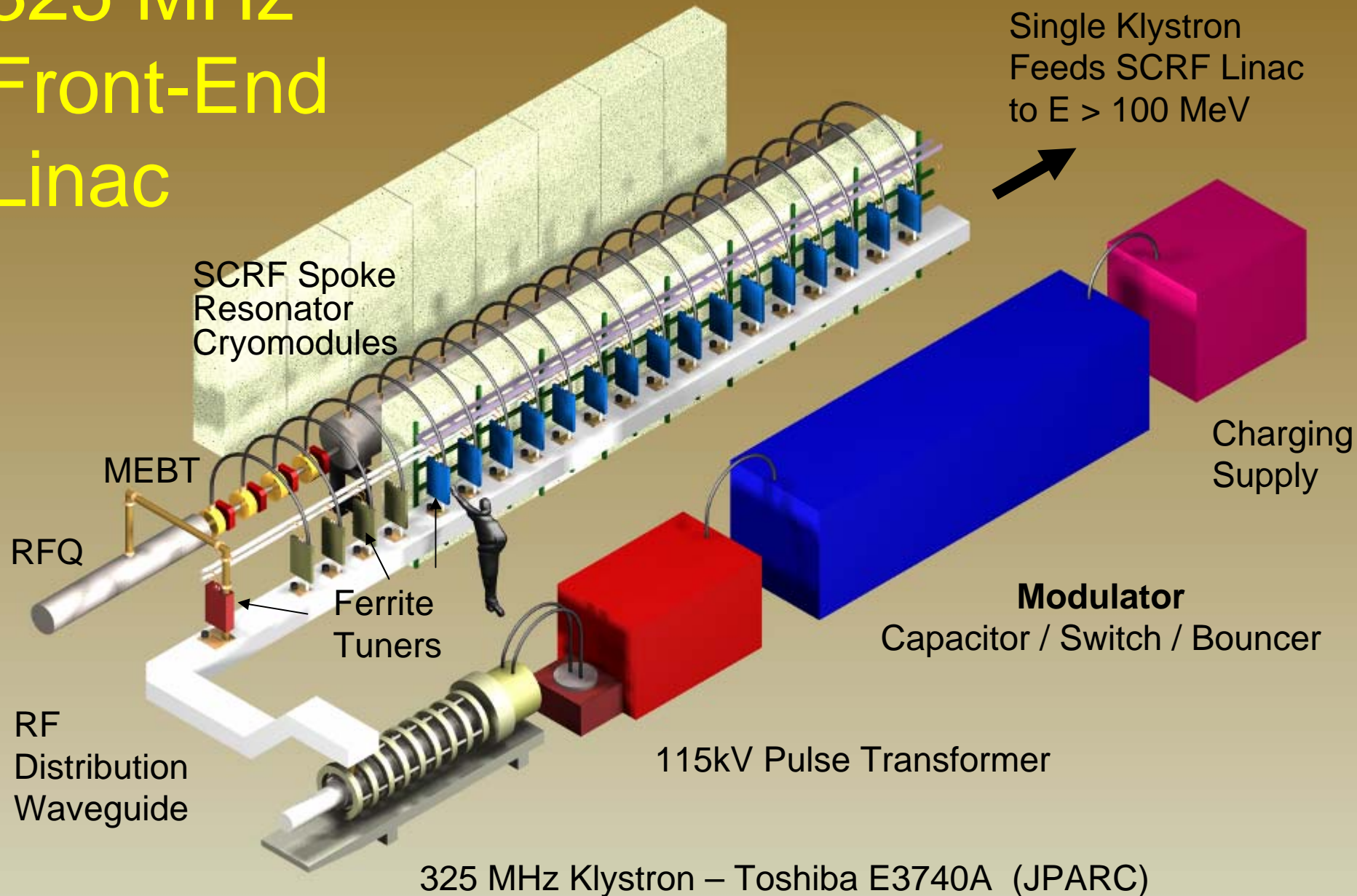
- Both Fermilab and BNL are developing a High Intensity Proton beam proposals to support neutrino physics program.
- Fermilab proton driver is designed such that it can also accelerate electrons and be used as light source.
- All these accelerators uses superconducting RF technology in Linac.
- These accelerators are at R&D stage and it provides a great opportunity for collaboration.
- India has also expressed interest in such an accelerator.
- A new initiative for R&D “SMTF” has started at Fermilab.
- CAT has expressed interest in collaborating on this R&D.

# 8 GeV Superconducting Linac

With X-Ray FEL, 8 GeV Neutrino & Spallation Sources, LC and Neutrino Factory



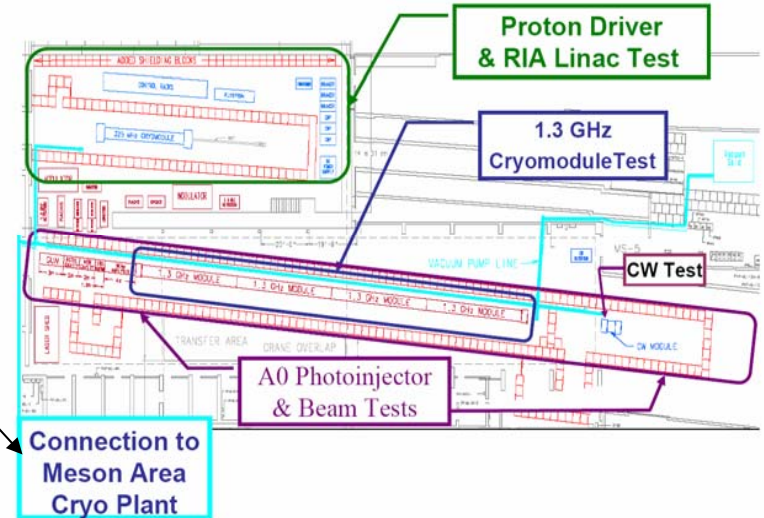
# 325 MHz Front-End Linac



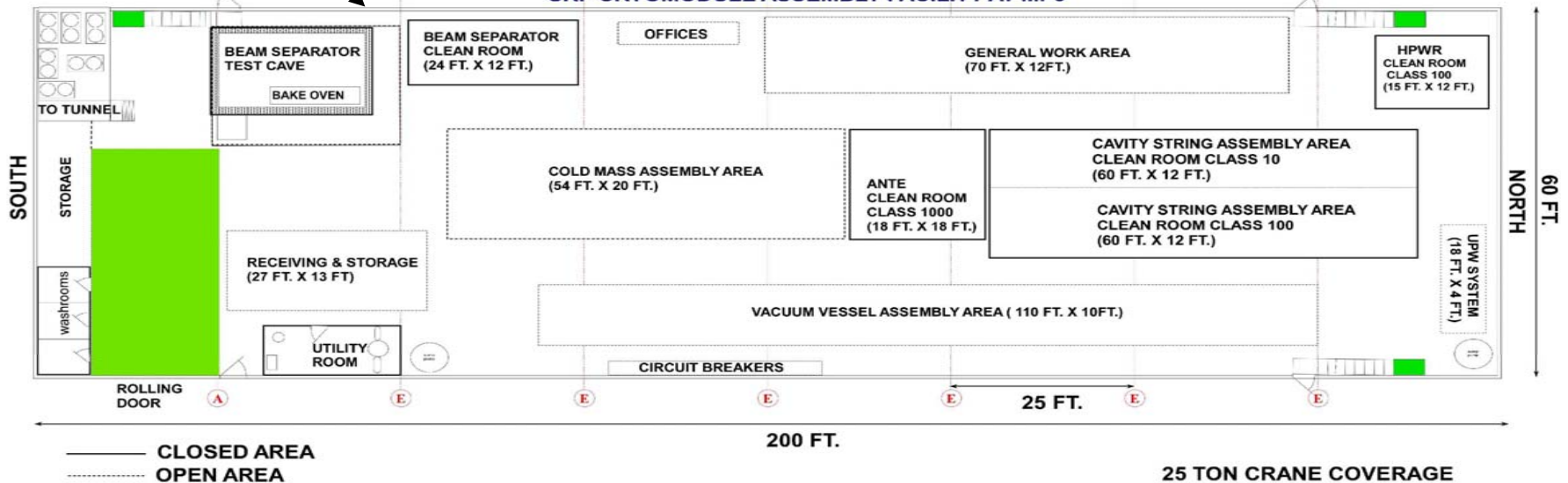
# Meson Area Fermilab



FNAL Meson Area SM&TF Layout Concept

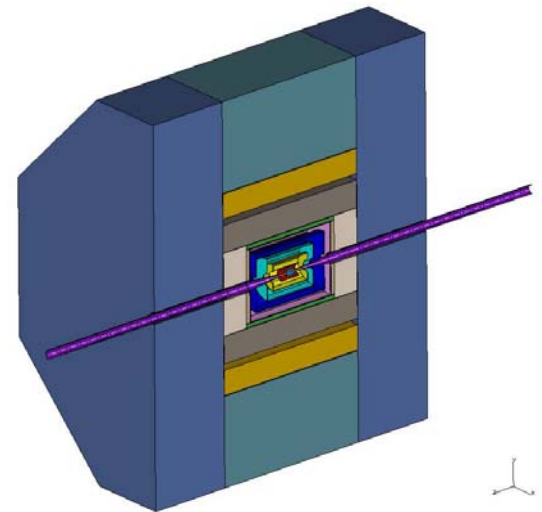


SRF CRYOMODULE ASSEMBLY FACILITY AT MP9

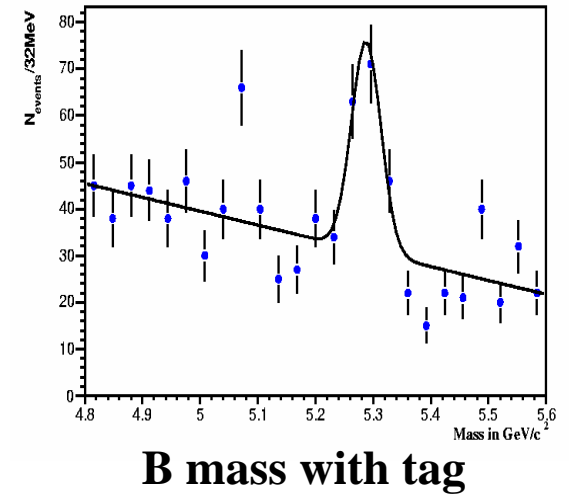
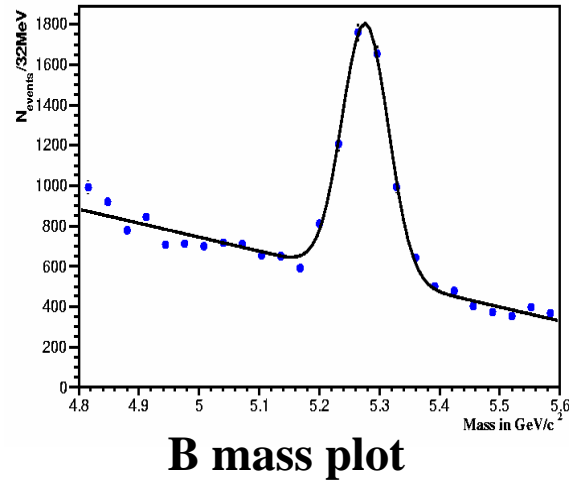
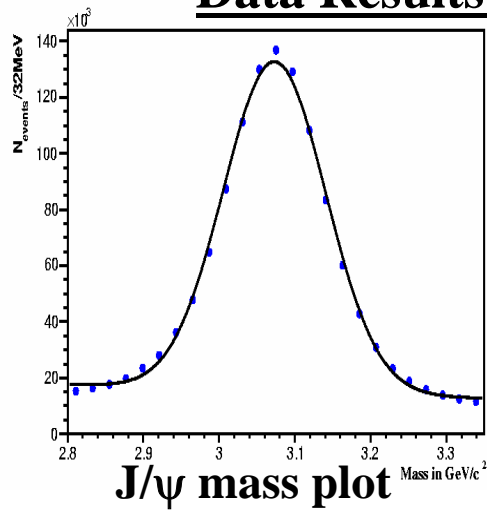


# Collaboration: Detector R&D

- At Fermilab India has been collaborating on D0 detector. At CERN India is collaborating on CMS.
- India has helped build Muon, Silicon detectors.
- For ILC a new detector collaboration “SiD” has formed jointly lead by Fermilab and SLAC.
- India has experienced and talented resources that it can contribute to this collaboration in both design and R&D.
- We are developing a proposal to submit on this collaboration



# Data Results for $B^+ \rightarrow J/\psi K^+$



## In Central detector region

**Efficiency =  $2.1 \pm 0.3\%$**

**Dilution =  $46 \pm 12\%$**

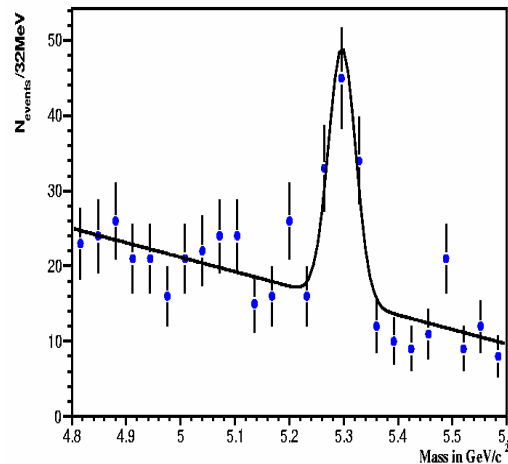
**Tagging power =  $0.46 \pm 0.26\%$**

## In All detector region

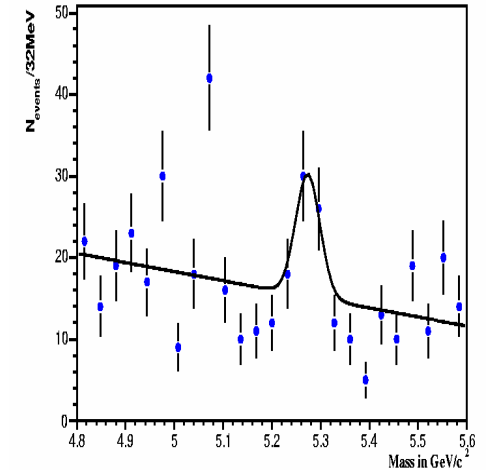
**Efficiency =  $2.3 \pm 0.38\%$**

**Dilution =  $43.4 \pm 15\%$**

**Tagging power =  $0.44 \pm 0.31\%$**



**B mass with right tag**



**B mass with wrong tag**

**For more information on this part of analysis, see D0 note # 4713**

# Proposal: Funding Request for Scientific Collaboration between India & US

- Request seed funding to start collaboration
  - Initial request is for three years of funding
  - Money only for people exchange
  - Money for R&D support is being requested separately
- Money to be used to
  - Fund long term (~ 1 year) visit by Indian scientists to US laboratories to work on specific accelerator related R&D
  - Fund accelerator schools in India where US and India can interact
  - Fund short term visit by US and Indian scientists to teach short courses, attend meetings etc.
- Funding Request
  - Long term visits – 5 people @ \$40K/year/per person
  - Accelerator schools - \$100K/year
  - Short term visits – 20 visits/year @ \$5K each
- Total request - \$400K/year ; ~\$1.2M over three years

# Possible Indian Contribution to ILC R&D

- International Linear Collider
  - Open collaboration from the beginning
  - \$5-10 billion project - \$10 billion cost problematic
  - six years of R&D
  - 5 years of construction
- ILC R&D is estimated to be ~15% of project cost – i.e. ~ \$1 billion
- A sizable contribution to ILC R&D from India could be similar to Indian contribution to LHC
- R&D effort will bring technology such as SCRF to India
- India's contribution (both intellectual and industrial) to building ILC is essential to help contain ILC construction costs and make the project feasible